MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2016/2017

EPM2036 – CONTROL THEORY

(All Sections / Groups)

01 JUNE 2017
2:30 p.m. - 4:30 p.m.
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This Question paper consists of 5 pages including cover page with 4 Questions only.
2. Attempt **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the answer booklet provided.

Question 1

(a) A control engineer, N.Minorsky, designed an innovative ship steering system in 1930's for the U.S. Navy. The system is represented by the block diagram shown in Fig. Q1 (a), where Y(s) is the ship's course and R(s) is the desired course.

(i) Determine the transfer functionY(s)/R(s), using block diagram reduction technique.

(ii) Draw the sginal flow graph.

[12 + 3 marks]

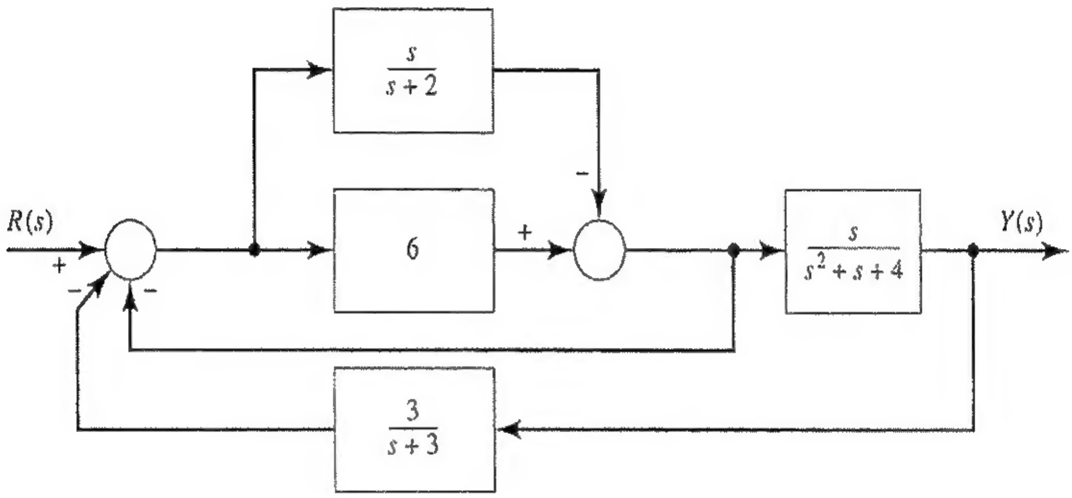

Fig. Q1 (a)

(b) Determine the transfer function of G(s) = $\theta_2(s)/T_1(s)$ for the mechanical system shown in Fig. Q1 (b). (Hints: assume zero initial condition)

[10 marks]

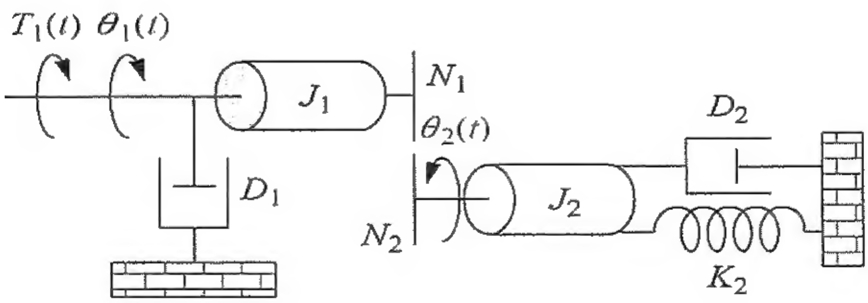

Fig. Q1 (b)

Continued...

Question 2

(a) Given the forward-path transfer function of a unity feedback system

$$G(s) = \frac{50}{s(s+10)}$$

For the unit step response of the system, determine the natural frequency, damping ratio and settling time for 2% error.

[6 marks]

(b) Given the forward-path transfer function of a unity feedback system

$$G(s) = \frac{81}{s(s+K)}$$

(i) Determine the value of K, if the unit step response of the system is critically damped.

[5 marks]

(ii) If $K=18$ determine the position constant K_p velocity constant K_v and acceleration constant K_a.

[6 marks]

(c) Consider the characteristic equation of a LTI system.

$$F(s) = s^4 + s^3 - 5s^2 + 2s + 6 = 0$$

(i) Determine the stability of the system using Routh Hurwith criteria.

(ii) Determine the number of roots in the right-half of s-plane.

[6+2 marks]

Continued...

Question 3

(a) A negative unity feedback system has a forward path transfer function $G(s)$ given by

$$G(s) = \frac{K(s+5)}{s(s^3 + 4s^2 + 6s + 4)}$$

For the root locus plot, determine the following:

(i) Starting and ending points of all branches

[2 marks]

(ii) Imaginary axis crossing points and the corresponding K value

[5 marks]

(b) Consider the feedback control system shown in Fig. Q3 (b).

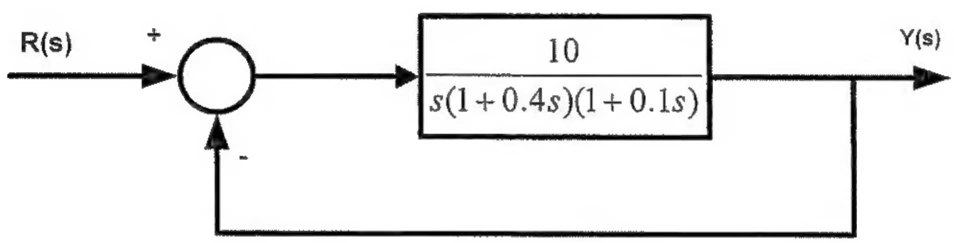

Fig. Q3 (b)

Plot the *Bode* magnitude plot of $G(s)$ in the semi-log paper.

[18 marks]

Continued...

Question 4

(a) Show how a Proportional-Derivative (PD) controller can be realized with only two op-amps.

[5 marks]

(b) A process has a transfer function $G_p(s) = \dfrac{1}{s+5}$. The process is to be controlled in closed-loop using a Proportional-Integral (PI) controller. Design the controller such that the steady-state error in response to a ramp input is 10% of the magnitude of the ramp. The closed-loop zero should be placed at -10.

[10 marks]

(c) A particular system has a forward path transfer function:

$$G(s) = \frac{5}{(s+1)\cdot(s+2)}$$

A Proportional-Integral (PI) controller is applied to control the system *G(s)*. Find the range of values of the integral constant (relative to the proportional constant) in order for the closed-loop system to be stable.

[10 marks]

End of Paper